(b)(1), (b)(3)

B54-1 SADM

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Mk 54 Special Atomic Demolition Munition

Timetable of Mk 54 Events

FALCON and DAVY CROCKETT Warhead Application

1958	Interest develops in lightweight, low-yield warheads for application to FALCON air-to-air missile and DAVY CROCKETT ground-to-ground recoilless rifle.

(b)(1), (b)(3)

1/15/59	Division of Military Application transfers nuclear part of the project to Los Alamos. XW-51 Warhead renamed the XW-54.
10/21/59	Proposed ordnance characteristics of the XW-54 Warhead presented to Special Weapons Development Board and accepted.
12/59	Mk 54 Mod 0 Warhead (FALCON Application) design released.
4/15/60	Mk 54 Mod 1 Warhead design released. This warhead contained no environmental sensing device and was canceled before production.
11/60	Mk 54 Mod 2 (DAVY CROCKETT Application) design released.
4/28/61	Early production of Mk 54 Mod 0 and Mod 2 Warheads.

Special Atomic Demolition Munition (SADM)

2/20/58	Assistant Secretary of Defense notifies United States Atomic Energy Commission that Army has requested feasibility study of an SADM.

(b)(1), (b)(3)

11/10/59	Sandia proposes SADM design to Division of Military Application.
4/7/60	Assistant Secretary of Defense requests Atomic Energy Commission to develop an SADM.
7/26/60	Military characteristics for SADM approved by Military Liaison Committee.
9/5/61	Military characteristics amended to require underwater pressure case.

Mid-1962 Timer development problems cause schedule delays.

(b)(1), (b)(3)

4/63 Mk 54 Mod 1 SADM design released.

8/64 Mk 54 Mod 1 SADM enters stockpile.

6/65 Mk 54 Mod 2 SADM enters stockpile.

UNCLASSIFIED

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~~RESTRICTED DATA~~

RS 3434/35

History of the Mk 54 Weapon

FALCON and DAVY CROCKETT Warhead Application

(b)(1), (b)(3)

The FALCON or GAR-11 was an air-to-air missile being engineered by the Hughes Aircraft Company for the Air Force. The DAVY CROCKETT was a ground-to-ground system designed to fire a projectile from a recoilless rifle and was being developed by the Army.[1]

(b)(1), (b)(3)

It was felt that the warhead would be compatible with the DAVY CROCKETT system and be able to withstand the acceleration produced by the recoilless rifle.

(b)(1), (b)(3)

It was felt that production FALCON warheads might be available by February 1961.

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Sandia commented on the warheads for the DAVY CROCKETT application in a teletype to the Division of Military Application November 18, 1959. The Military Liaison Committee had suggested that the environmental sensing device could be omitted from early warhead production, if this would help to meet the desired operational availability date, but Sandia felt that the sensing device should be provided. It was noted that sooner or later it would be necessary to open the weapons in the field for retrofit or maintenance and, if the adaption kit was disconnected in this process, all protection would be lost. Sandia stated that it would be possible to produce complete weapons by the desired date.[15]

Tests of the XW-54/DAVY CROCKETT were started at the Diamond Ordnance Fuse Laboratory (which had been assigned responsibility for fuze development) in the fall of 1959. The warheads were fired from a 155mm mortar and underwent accelerations of 1800 to 2000 g's. Firings were made to a range of about 1500 yards, and all fuzing and firing functions checked out normally.[16]

New development nomenclatures were assigned in late 1959. It had been found impossible to design one environmental sensing device that would operate properly in the diverse environments of both FALCON and DAVY CROCKETT. It was then decided that two different devices would be supplied, although otherwise the warhead assembly and installation would be identical. Design release of the XW-54 was made in December 1959, and this assembly contained an environmental sensing device for the FALCON. Work continued on an XW-54-X1 with a different sensing device for the DAVY CROCKETT; and a third configuration, the XW-54-X2, would have no sensing device and would be used for early DAVY CROCKETT capability.[17]

By January 1960 ~~contact preclusion~~ tests had been completed, demonstrating that ground impact of the warhead with X-unit and fuze armed and fuze thyratron filaments hot would probably produce a nuclear burst.[18]

(b)(1), (b)(3)

Sandia notified the Division of Military Application April 15 1960, that the

Instrumentation errors were discovered on two flights, and aircraft troubles developed on two others, but the rest of the tests were completely successful.[26]

Report SC4632(WD), Final Development Report for the Mk 54 Warhead Systems, was accepted by the Design Review and Acceptance Group December 14, 1961 and forwarded to the Division of Military Application February 19, 1962. The report noted that the warhead was 10.862 inches in diameter, 15.716 inches long, and weighed about 50.9 pounds. The design included a motor-driven chopper-converter system and contained no power supply.

(b)(1), (b)(3)

The electric system consisted of a firing set and detonator assemblies. This system was a standard chopper-converter design largely using off-the-shelf components. It contained no power source, no one-shot devices, and no components requiring field monitoring, although the environmental sensing devices could be monitored.

(b)(1), (b)(3)

These components were interconnected by printed wiring, and the entire assembly was encapsulated in foamed plastic in a fiberglass housing.

Since the fiberglass housing was electrically nonconductive, it was coated with a conductive lacquer to provide an electrostatic shield from warhead connector to rear cap. This coating was requested by the Department of Defense due to the susceptibility of the fuze to radiated electrical noise generated by the firing set. A connector cover and seal were installed on the

warhead connector after the firing set was assembled to the rear cap of the warhead case.

(b)(3)

Environmental sensing devices were placed in the input lines to the converter transformer, and these devices remained open during warhead storage and handling, and closed during a launch environment.

In the Mk 54 Mod 0 Warhead for the FALCON application, the warhead was installed in the missile section with its longitudinal axis offset about 1/8 inch to allow room for missile cabling. The FALCON was an air-to-air, semi-active radar homing missile, designed to be launched from F-102A aircraft. The missile diameter was 11.4 inches, length 85 inches, wingspan 24.5 inches, and weight 260 pounds at launch and 200 pounds after motor burnout. The rocket motor produced a total impulse of about 12,900 pound-seconds, which applied an acceleration of 20 to 40 g's to the missile, depending on launch conditions. After rocket-motor burnout, the missile tracked the target on a collision course. The guidance system homed the missile on a target that was

either radar-illuminated by the launch aircraft or by electronic countermeasures emitted by the target.

The missile had a proximity fuze with an operating radius of about 100 feet for a 40-square-foot target. The antenna pattern was in a plane perpendicular to the longitudinal axis of the missile. The output of the proximity fuze was connected to the fuze relay through a safing and arming device.

(b)(3)

The warhead power source in the fuze consisted of two 28-volt thermal batteries. The batteries were initiated about 0.5 second prior to launch and came up to voltage about 1 second after initiation. Battery output was applied to the warhead through the safing and arming device at arm time. This device was a switching mechanism that provided warhead arming by connecting the power supply to the warhead connector and preparing the warhead for firing by connecting the proximity fuze to the fuze relay. This latter device provided switch closure between firing capacitors and pulse transformers of the firing set.

The safing and arming device was latched in the SAFE position until about 1.5 seconds prior to launch. The mechanism had two sets of cam-operated contacts. One set, which was normally open, armed the warhead, and the other set, which was normally closed, disabled the warhead after guided flight in the event of a miss. Both sets were committed during launch acceleration after an environment of about 14 g-seconds.

During the drag phase of deceleration, a spring force developed during acceleration drove the switches to the ARM and DISABLE positions through escapement timers. The escapement time depended on the spring force developed during acceleration and on the deceleration experienced by the missile after motor burnout.

(b)(1), (b)(3)

(b)(1), (b)(3)

The arm contacts were spaced to provide warhead power 0.3 to 0.5 second prior to connecting the fuze relay to the proximity fuze.

(b)(1), (b)(3)

The Mk 54 Mod 2 Warhead was designed for the DAVY CROCKETT, the Army's Battle Group Atomic Delivery System. There were two DAVY CROCKETT systems; the XM28, a lightweight, three-man portable system using a 120mm recoilless rifle with a range of 350 to 2000 meters; and the XM29, a vehicle-transported system using a 155mm recoilless rifle with a range from 350 to 4000 meters. Each system fired an XM388 projectile.

The XM388 projectile included the warhead, rear body and fin assembly, and fiberglass windshield. The projectile had a diameter of 11 inches, length of 30 inches, and weight of 76 pounds.

(b)(3)

A manually operated ~~arm/safe~~ switch interrupted the power supply to the warhead when in the SAFE position. The fuze incorporated a mechanical timer to set the time of flight and to provide safe-separation distance. The fuze contained thermal batteries activated at missile launch to supply power to the warhead and squib switches to close warhead firing circuits.

(b)(1), (b)(3)

At launch, the fuze timer mechanism and the inertial switches in the warhead were actuated. Concurrently, the 28-volt thermal batteries in the fuze were activated, and this action started chopper motors in the firing set. When the preset time was reached, four sets of switches in the timer mechanism closed. Closure of two sets of these switches armed the warhead and initiated the X-unit thermal batteries. Closure of the other two sets of switches connected the X-unit thermal batteries to the fuze. Upon sensing

the selected burst height, a set of squib switches closed and triggered the firing set.[23]

Special Atomic Demolition Munition

The Assistant Secretary of Defense notified the United States Atomic Energy Commission, February 20, 1958, that the Army had recently evaluated atomic demolition devices. There was a requirement for a small and light munition that could be carried by one man. This project, which had been initially called the Tactical Atomic Demolition Munition, would be known as the Special Atomic Demolition Munition (SADM), and a feasibility study was authorized.[27]

(b)(1), (b)(3)

The project was delayed while attention was being given to the design of the XW-54 Warhead for FALCON and DAVY CROCKETT applications, although Sandia informed Albuquerque Operations Office, April 23, 1959, that the XW-54 could be considered for SADM application.[6]

Sandia forwarded a proposal for a nuclear demolition munition to the Division of Military Application November 10, 1959. A modified XW-54 Warhead was proposed, containing an integral fuze compactly packaged in a lightweight sealed waterproof housing, and it was suggested that the entire munition be procured and fabricated by the Atomic Energy Commission. The design would provide a rugged munition small enough for covert missions and capable of being rapidly prepared for firing under conditions of high operational stress where time was critical.[30] It was noted that the only existing munition that approached these requirements was the T-4, an adaptation of the Mk 9 gun-type weapon. However, the T-4 was packaged in four 40-pound sections and required four men for delivery. It was felt that an XW-54 SADM would have a diameter of 11-7/8 inches, length of 17-1/2 inches, and weight of 56 pounds including carrying case.[31]

Application February 2, 1961. The report had been presented to the Design Review and Acceptance Group of Field Command and accepted, except for the capability of the design to meet timer error and premature probability requirements.[40]

(b)(1), (b)(3)

A pressure casing was subsequently developed for this purpose.

Sandia notified Albuquerque Operations Office June 1, 1962 that timer problems had arisen, and that production would be delayed until August 1963. Sandia investigated the possibility of furnishing interim units having some limitations by February 1963, but these shortcomings could not be adequately defined until development timers became available in November 1962.[42]

The Division of Military Application forwarded another amendment to the SADM military characteristics December 11, 1962

(b)(1), (b)(3)

Each digit would have a range from 0 through 9, and the combination would be capable of change without lock disassembly, after removal of the lock-secured cover from the munition. The lock would be capable of at least 500 complete dialing operations, locking and unlocking, and at least 50 combination changes without failure. The lock would have maximum

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the dial was protected by a cover sealed with an O-ring. The safed or armed condition of the firing set could be observed through a window in the lock-secured cover.

(b)(1), (b)(3)

The container had a negative buoyancy of about 5 pounds in water ~~and~~ was provided with an external arming device that permitted underwater arming.

(b)(1), (b)(3)

(b)(1), (b)(3)

With the control in the ARM position, the time-delay setting could not be changed. When the arm/safe control was returned to the SAFE position, all safety features and interlocks were reengaged.

(b)(1), (b)(3)

Upon completion of manual arming and after the preset time-delay interval, the timer provided firing signals which activated the electric detonator. This detonator created a shock wave that actuated the explosive plane-wave

generator and created a high-energy planar shock wave that impinged on the transducer. This resulted in a rapid stressing of the ceramic transducer and produced a high-peak-energy pulse that initiated the high-explosive/nuclear system detonators. The resultant implosion of the high explosive initiated the nuclear reaction.[54]

A Mk 54 Mod 2 SADM, with the same diameter and length attained early production in June 1965.

(b)(1), (b)(3)

The weight was increased to 70 pounds.[55]

Hardtack -- A nuclear series of 72 tests. Hardtack I was held at the Pacific Proving Grounds from April 28 to August 18, 1958. The decision to declare a moratorium on testing resulted in Hardtack II, held at the Nevada Test Site between September 12 and October 30, 1958.

High-Explosive Sphere -- The ball of high explosive that surrounds the nuclear primary and is designed to produce the implosion effect when detonated.

(b)(1), (b)(3)

Kiloton -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is equivalent to the detonation effect of 1000 tons of high explosive.

Lawrence Radiation Laboratory -- A change of name for the University of California Radiation Laboratory (which see), effective October 1958.

Los Alamos Scientific Laboratory -- A nuclear design organization located at Los Alamos, New Mexico.

Mach -- A measure of speed. Mach 1.0 is the speed of sound, or 738 miles per hour at sea level.

Military Characteristics -- The attributes of a weapon that are desired by the Military.

Military Liaison Committee -- A Department of Defense committee established by the Atomic Energy Act to advise and consult with the AEC on all matters relating to military applications of atomic energy.

Millisecond -- One thousandth of a second.

Missile Warhead -- The explosive or nuclear device carried by a missile.

(b)(1), (b)(3)

One-Point-Safe Weapon -- A weapon that will not produce a nuclear yield when detonated at one point on the surface of the high explosive.

Operation Hardtack -- See Hardtack.

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Radar -- Named for Radio Detecting and Ranging. Radars emit a pulse of high-frequency energy and measure the time lapse from that transmission to receipt of a reflected electrical "echo" from an object. This time measurement determines the distance of the object from the transmitting antenna of the radar.

Retrofit -- To modify a weapon, i.e., "retroactively outfit" it with changed material.

Safing -- Putting a weapon in condition such that it cannot fire.

Spark Gap -- An air gap that prevents passage of electrical current. When the gap is ionized, current is conducted.

Special Weapons Development Board -- A joint Sandia-Military board at Sandia Base to provide local guidance on weapons design.

Squib -- A device containing a small powder charge. When detonated, the resulting gas pressure closes a switch or performs a similar action. A light, quick-acting, one-shot device.

Thermal Battery -- A battery whose electrolyte is in a solid state while inactive. To activate, heat is applied to the electrolyte, melting it and putting the battery into active output condition.

Thyratron -- A grid-controlled electron tube.

Ton (Yield) -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-ton yield is equivalent to the detonation effect of 2000 pounds of high explosive.

University of California Radiation Laboratory -- A laboratory located at Livermore, California. Initially founded for work on thermonuclear designs.

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